CLAIMS

1. A film forming method in which a reaction gas is brought into contact with a heated catalyzer and an electric field of not higher than a glow discharge starting voltage is caused to act on the produced reactive species, thereby providing kinetic energy and carrying out vapor growth of a predetermined film on a base.

2. The film forming method as claimed in claim 1, wherein a DC voltage not higher than the glow discharge starting voltage is applied to direct the reactive species toward the base.

3. The film forming method as claimed in claim 1, wherein a voltage not higher than the glow discharge starting voltage and produced by superimposing an AC voltage on a DC voltage is applied.

4. The film forming method as claimed in claim 3, wherein the AC voltage is a high-frequency voltage and/or a low-frequency voltage.

5. The film forming method as claimed in claim 4, wherein the high-frequency voltage has a frequency of 1 MHZ to 10 GHz and the low-frequency voltage has a frequency less than 1 MHZ.

6. The film forming method as claimed in claim 1, wherein as the voltage forming the electric field (with its absolute value being not higher than the glow discharge starting voltage), only a high-frequency AC voltage, or only a low-frequency AC voltage, or a voltage produced by superimposing a high-frequency AC voltage on a

low-frequency AC voltage.

7. The film forming method as claimed in claim 6, wherein the high-frequency voltage has a frequency of 1 MHZ to 10 GHz and the low-frequency voltage has a frequency less than 1 MHZ.

8. The film forming method as claimed in claim 1, wherein the catalyzer is arranged between the base and an electrode for applying the electric field.

9. The film forming method as claimed in claim 8, wherein a gas supply port for leading out the reaction gas is formed in the electrode.

10. The film forming method as claimed in claim 1, wherein the catalyzer and an electrode for applying the electric field are arranged between the base and a reaction gas supply means.

11. The film forming method as claimed in claim 1, wherein the catalyzer or an electrode for applying the electric field is formed in the shape of a coil, wire, mesh, or porous plate.

12. The film forming method as claimed in claim 1, wherein the reactive species are irradiated with charged particles for preventing charging.

13. The film forming method as claimed in claim 12, wherein an electron beam or proton is used as the charged particles.

14. The film forming method as claimed in claim 1, wherein after vapor growth of the predetermined film, the base is taken out of a deposition chamber and a voltage is applied between predetermined electrodes to generate plasma discharge, thereby

cleaning the inside of the deposition chamber with the plasma discharge.

15. The film forming method as claimed in claim 1, wherein the vapor growth is carried out under a reduced pressure or a normal pressure.

16. The film forming method as claimed in claim 1, wherein the catalyzer is heated to a temperature within a range of 800 to 2000°C and lower than its melting point, and the reactive species, produced by catalytic reaction or thermal decomposition of at least a part of the reaction gas with the heated catalyzer, are used as material species so as to deposit a thin film by a thermal CVD method on the base heated to the room temperature to 550°C.

17. The film forming method as claimed in claim 16, wherein the catalyzer is heated by its own resistance heating.

18. The film forming method as claimed in claim 1, wherein any one of the following gases (a) to (p) is used as a material gas:

(a) silicon hydride or its derivative;

(b) mixture of silicon hydride or its derivative and gas containing hydrogen, oxygen, nitrogen, germanium, carbon, tin, or lead;

(c) mixture of silicon hydride or its derivative and gas containing impurity made of a group III or group V element of the periodic table;

(d) mixture of silicon hydride or its derivative, gas containing hydrogen, oxygen, nitrogen, germanium, carbon, tin, or lead, and gas containing impurity made of a group III or group V element of the periodic table;

(e) aluminum compound gas;

(f) mixture of aluminum compound gas and gas containing hydrogen or oxygen;

(g) indium compound gas;

(h) mixture of indium compound gas and gas containing oxygen;

(i) fluoride gas, chloride gas or organic compound gas of a refractory metal;

(j) mixture of fluoride gas, chloride gas or organic compound gas of a refractory metal and silicon hydride or its derivative;

(k) mixture of titanium chloride and gas containing nitrogen and/or oxygen;

(l) copper compound gas;

(m) mixture of aluminum compound gas, hydrogen or hydrogen compound gas, silicon hydride or its derivative, and/or copper compound gas;

(n) hydrocarbon or its derivative;

(o) mixture of hydrocarbon or its derivative and hydrogen gas; and

(p) organic metal complex, alkoxide.

19. The film forming method as claimed in claim 18, wherein the following thin films and tubular carbon polyhedrons are formed by vapor growth: polycrystal silicon; single-crystal silicon; amorphous silicon; microcrystal silicon; compound semiconductors such as gallium-arsenide, gallium-phosphorus, gallium-indium-phosphorus, gallium-nitride and the like; semiconductor thin films of silicon carbide, silicon-germanium and the like; a diamond thin film; an n-type or p-type carrier

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impurity-containing diamond thin film; a diamond-like carbon thin film; an insulating thin films of silicon oxide, impurity-containing silicon oxide, silicon nitride, silicon oxynitride, titanium oxide, tantalum oxide, aluminum oxide and the like; oxidative thin films of indium oxide, indium-tin oxide, palladium oxide and the like; metal thin films of refractory metals such as tungsten, molybdenum, titanium, zirconium and the like, conductive nitride metal, copper, aluminum, aluminum-silicon alloy, aluminum-silicon-copper alloy, aluminum-copper alloy and the like; a thin film having a high dielectric constant such as BST and the like; and ferroelectric thin films made of PZT, LPZT, SBT, BIT and the like.

20. The film forming method as claimed in claim 1, wherein the catalyzer is made of at least one type of material selected from the group consisting of tungsten, thoria-containing tungsten, titanium, molybdenum, platinum, palladium, vanadium, silicon, alumina, ceramics with metal adhered thereto, and silicon carbide.

21. The film forming method as claimed in claim 1, wherein the catalyzer is heated in a hydrogen-based gas atmosphere before supplying the material gas.

22. The film forming method as claimed in claim 1, wherein a thin film is formed for a silicon semiconductor device, a silicon semiconductor integrated circuit device, a silicon-germanium semiconductor device, a silicon-germanium semiconductor integrated circuit device, a compound semiconductor device, a compound semiconductor integrated circuit device, a silicon carbide semiconductor device, a silicon carbide semiconductor integrated circuit device, a high dielectric memory

semiconductor device, a ferroelectric memory semiconductor device, a liquid crystal display device, an electroluminescence display device, a plasma display panel (PDP) device, a field emission display (FED) device, a light-emitting polymer display device, a light-emitting diode display device, a CCD area/linear sensor device, a MOS sensor device, or a solar battery device.

23. A film forming apparatus comprising reaction gas supply means, a catalyzer, heating means for the catalyzer, electric field application means for applying an electric field of not higher than a glow discharge starting voltage, and a suscepter for supporting a base on which a film to be formed.

24. The film forming apparatus as claimed in claim 23, wherein the electric field application means has a power source for applying a DC voltage not higher than the glow discharge starting voltage.

25. The film forming apparatus as claimed in claim 23, wherein the electric field application means has a power source for applying a voltage not higher than the glow discharge starting voltage and produced by superimposing an AC voltage on a DC voltage.

26. The film forming apparatus as claimed in claim 25, wherein the AC voltage is a high-frequency voltage and/or a low-frequency voltage.

27. The film forming apparatus as claimed in claim 26, wherein the high-frequency voltage has a frequency of 1 MHZ to 10 GHz and the low-frequency voltage has a frequency less than 1 MHZ.

28. The film forming apparatus as claimed in claim 23, wherein as the voltage forming the electric field (with its absolute value being not higher than the glow discharge starting voltage), only a high-frequency AC voltage, or only a low-frequency AC voltage, or a voltage produced by superimposing a high-frequency AC voltage on a low-frequency AC voltage.

29. The film forming apparatus as claimed in claim 28, wherein the high-frequency voltage has a frequency of 1 MHZ to 10 GHz and the low-frequency voltage has a frequency less than 1 MHZ.

30. The film forming apparatus as claimed in claim 23, wherein the catalyzer is arranged between the base and an electrode for applying the electric field.

31. The film forming apparatus as claimed in claim 30, wherein a gas supply port for leading out the reaction gas is formed in the electrode.

32. The film forming apparatus as claimed in claim 23, wherein the catalyzer and an electrode for applying the electric field are arranged between the base and a reaction gas supply means.

33. The film forming apparatus as claimed in claim 23, wherein the catalyzer or an electrode for applying the electric field is formed in the shape of a coil, wire, mesh, or porous plate.

34. The film forming apparatus as claimed in claim 23, wherein charged particle irradiation means is arranged near the suscepter.

35. The film forming apparatus as claimed in claim 34, wherein the charged

particle irradiation means comprises electron beam irradiation means or proton irradiation means.

36. The film forming apparatus as claimed in claim 23, wherein plasma discharge forming means is provided for applying a voltage between predetermined electrodes to clean the inside of a deposition chamber.

37. The film forming apparatus as claimed in claim 23, wherein the formation of the film is carried out under a reduced pressure or a normal pressure.

38. The film forming apparatus as claimed in claim 23, wherein the catalyzer is heated to a temperature within a range of 800 to 2000°C and lower than its melting point, and the reactive species, produced by catalytic reaction or thermal decomposition of at least a part of the reaction gas with the heated catalyzer, are used as material species so as to deposit a thin film by a thermal CVD method on the base heated to the room temperature to 550°C.

39. The film forming apparatus as claimed in claim 38, wherein the catalyzer is heated by its own resistance heating.

40. The film forming apparatus as claimed in claim 23, wherein any one of the following gases (a) to (p) is used as a material gas:

(a) silicon hydride or its derivative;

(b) mixture of silicon hydride or its derivative and gas containing hydrogen, oxygen, nitrogen, germanium, carbon, tin, or lead;

(c) mixture of silicon hydride or its derivative and gas containing impurity

made of a group III or group V element of the periodic table;

(d) mixture of silicon hydride or its derivative, gas containing hydrogen, oxygen, nitrogen, germanium, carbon, tin, or lead, and gas containing impurity made of a group III or group V element of the periodic table;

(e) aluminum compound gas;

(f) mixture of aluminum compound gas and gas containing hydrogen or oxygen;

(g) indium compound gas;

(h) mixture of indium compound gas and gas containing oxygen;

(i) fluoride gas, chloride gas or organic compound gas of a refractory metal;

(j) mixture of fluoride gas, chloride gas or organic compound gas of a refractory metal and silicon hydride or its derivative;

(k) mixture of titanium chloride and gas containing nitrogen and/or oxygen;

(l) copper compound gas;

(m) mixture of aluminum compound gas, hydrogen or hydrogen compound gas, silicon hydride or its derivative, and/or copper compound gas;

(n) hydrocarbon or its derivative;

(o) mixture of hydrocarbon or its derivative and hydrogen gas; and

(p) organic metal complex, alkoxide.

41. The film forming apparatus as claimed in claim 40, wherein the following thin films and tubular carbon polyhedrons are formed by vapor growth: polycrystal

silicon; single-crystal silicon; amorphous silicon; microcrystal silicon; compound semiconductors (gallium-arsenide, gallium-phosphorus, gallium-indium-phosphorus, gallium-nitride and the like); semiconductor thin films of silicon carbide, silicon-germanium and the like; a diamond thin film; an n-type or p-type carrier impurity-containing diamond thin film; a diamond-like carbon thin film; an insulating thin films of silicon oxide, impurity-containing silicon oxide, silicon nitride, silicon oxynitride, titanium oxide, tantalum oxide, aluminum oxide and the like; oxidative thin films of indium oxide, indium-tin oxide, palladium oxide and the like; metal thin films of refractory metals such as tungsten, molybdenum, titanium, zirconium and the like, conductive nitride metal, copper, aluminum, aluminum-silicon alloy, aluminum-silicon-copper alloy, aluminum-copper alloy and the like; a thin film having a high dielectric constant such as BST and the like; and ferroelectric thin films made of PZT, LPZT, SBT, BIT and the like.

42. The film forming apparatus as claimed in claim 23, wherein the catalyzer is made of at least one type of material selected from the group consisting of tungsten, thoria-containing tungsten, titanium, molybdenum, platinum, palladium, vanadium, silicon, alumina, ceramics with metal adhered thereto, and silicon carbide.

43. The film forming apparatus as claimed in claim 23, wherein the catalyzer is heated in a hydrogen-based gas atmosphere before supplying the material gas.

44. The film forming apparatus as claimed in claim 23, wherein a thin film is formed for a silicon semiconductor device, a silicon semiconductor integrated circuit

device, a silicon-germanium semiconductor device, a silicon-germanium semiconductor integrated circuit device, a compound semiconductor device, a compound semiconductor integrated circuit device, a silicon carbide semiconductor device, a silicon carbide semiconductor integrated circuit device, a high dielectric memory semiconductor device, a ferroelectric memory semiconductor device, a liquid crystal display device, an electroluminescence display device, a plasma display panel (PDP) device, a field emission display (FED) device, a light-emitting polymer display device, a light-emitting diode display device, a CCD area/linear sensor device, a MOS sensor device, or a solar battery device.

45. The film forming apparatus as claimed in claim 30, further comprising means for measuring a current flowing between the electrode and the suscepter.